

Remarks

Claims 1 - 16 are pending. Favorable reconsideration is respectfully requested.

Claim 1 has been amended to indicate that the reactor product gas feed to the recycle gas scrubber is direct, i.e. without a condensation unit or distillation column preceding the scrubber. Support may be found in the specification and in Figure 1 which illustrates this process. New claim 15 has been added to reflect that venting of the reactor, which is only necessary to a small degree in Applicants' process, is such that only about 2% of ethylene is lost in the purge. Thus, the process typically consumes about 98% or more of the ethylene supplied. Support may be found on page 6, lines 16 - 17. New claim 16 has been added to recite that the ethylene from the scrubber which is not recycled to the vinyl acetate process is fed to a process for producing acetic acid from ethylene. Support may be found on page 6, line 1, and Examples 1 - 3. No new matter is added by virtue of the amendment to claim 1 or by the presentation of new claims 15 and 16.

Claims 6 - 11 have been rejected under 35 U.S.C. § 103(a) over Williams et al. EP 098557 ("*Williams*") in view of Baba U.S. 3,404,177 ("*Baba*") further in view of Broz U.S. 3,904,656 ("*Broz*") and Lippert et al., U.S. 5,705,683 ("*Lippert*"). Applicants respectfully traverse this rejection.

The present invention is directed to a highly improved process for vinyl acetate production which allows recycle of a portion of ethylene from the product gas stream and reuse of the remainder of the ethylene in other ethylene-consuming processes.

In the production of vinyl acetate, ethylene is reacted with acetic acid in the vapor phase over a supported catalyst. The conversion of ethylene in the reactor is very limited, even at high ethylene concentrations, and since ethylene is a high cost feedstock, its use must be maximized. At the same time, incineration of ethylene creates large amounts of CO₂, a

"greenhouse" gas, and thus venting or purging of the reactor, with its high concentration of ethylene, is preferably avoided.

Baba illustrates an old (1965, issued 1968) process for production of vinyl acetate. The age of this reference as well as others attests to the long felt need of improving the vinyl acetate process. *Baba* is essentially directed to improving the vinyl acetate recovery process, not vinyl acetate synthesis. *Baba* indicates (column 4) that the reactor may contain considerable CO₂ and that the total of inerts (N₂, Ar, CO₂) should not exceed 60% (column 5, lines 1, 2).

To recycle the ethylene to the reactor, *Baba* employs a complex purification system wherein the product gas stream is first passed to a distillation column, where vinyl acetate product, acetaldehyde, ethylene, water, and carbon dioxide (and other inerts, e.g. N₂, Ar) are taken as an overhead. The overhead stream is then passed to a condenser, followed by a separator. Reference may be made to *Baba's* Figure. The separator provides two liquid phases, an aqueous phase of vinyl acetate, acetaldehyde and water, and an organic phase containing the same ingredients, but in different ratio (little water). A third stream, the vapor stream, contains ethylene, oxygen, and carbon dioxide. This stream (16) also contains vinyl acetate and water (See Table II). As shown in the figure, a portion of this feed is recycled to the reactor (20) while the remainder is vented (burned).

Williams is a much later publication which touts improvements in the vinyl acetate process, further evidence that the process, in 1998, was still in need of improvement. *Williams* is directed to an improvement in vinyl acetate synthesis (not to recovery as is *Baba*), wherein a very high percentage of ethylene is contained in the reactor, greater than 60 mol percent. To maintain this high percentage of ethylene, the amounts of inerts which accumulate in the reactor must be severely limited, otherwise the ethylene will be "diluted" and will fall below 60 mol%. This is in contrast to *Baba*, which indicates that inerts may be as high as 60%.

In order to reduce the concentration of inerts, *Williams* suggests ten methods to reduce nitrogen and argon concentrations in ¶[0028]. Note that using CO₂ purge gas for

instruments is one of these. While these methods, all of which are expensive, reduce N₂ and Ar inerts, they do nothing for CO₂ inerts, and actually increase the concentration of CO₂.

While *Williams* is not fundamentally directed to recycle of the ethylene in the product gas stream,¹ *Williams* does acknowledge that total recycle must take place to run his process efficiently. However, to do so, the ethylene must be treated to remove condensables by condensation, followed by membrane separation or chemical treatment ¶[0033]. The resulting ethylene is quite pure, having had carbon dioxide and condensables separated, but still contains Ar and N₂. Thus, when the "pure" ethylene is recycled to the reactor, N₂ and Ar continue to build up, and reactor venting (to a flare) must still occur in order to remove these. Reducing the concentration of N₂ and Ar in the reactor to half their concentration, for example, will require flaring half the contents of the reactor. Since the reactor contains a large amount of ethylene on a percentage basis, this process involves a very large waste of expensive ethylene as well as release of large amounts of CO₂ to the biosphere.

Thus, the process of *Williams*, while it increases selectivity and yield of vinyl acetate due to its high ethylene content, is still wasteful of ethylene. All the ethylene in *Williams* process is recycled, and a considerable amount of fresh and recycled ethylene is also lost when venting the reactor.

Baba and *Williams* are not combinable references, and even if combined, do not, in combination, teach or suggest the present invention. *Baba*, is not directed to vinyl acetate synthesis, but to vinyl acetate recovery. *Williams* is not directed to vinyl acetate recovery, but to vinyl acetate synthesis. While both are related to vinyl acetate, their objects are totally different. Moreover, while *Williams* teaches that the product stream is first condensed to separate liquid components from the gas stream (¶[0033]; step i)), *Baba* indicates that such a conventional process step should not be performed (col. 2, lines 3 - 15), because this conventional step, which is taught by *Williams*, causes substantial decomposition and loss of the desired vinyl acetate product.

¹ *Williams* is fundamentally directed to synthesis of vinyl acetate using a very high mol percentage of ethylene in the reactor.

Thus, *Baba* first separates the majority of vinyl acetate and removes it, together with ethylene (and inerts) as an overhead, and only then condenses the vinyl acetate, now containing minimal acetic acid (line 13; Table II ("trace")). By contrast, *Williams* performs the conventional condensation which *Baba* states should not be used, and separates a gas stream from a liquid condensate which contains vinyl acetate, acetic acid, and water. The teachings of *Williams* and *Baba* are directly contrary to each other, and the references cannot be combined for this reason. The non-combinability is not, as is the case with some combinations of references, based on any concept of non-analogous references. Both references are directed to the same general field of endeavor - the vinyl acetate process. Nor is the non-combinability based on the fact that the objects addressed by *Williams* and *Baba* are different. Rather, the references cannot be physically combined, because their teachings are opposing.

Furthermore, *Baba* teaches only that a portion of the ethylene may be recycled, and teaches that the remaining ethylene is vented, while *Williams*, as acknowledged by the Office, teaches that the entire amount of ethylene is recycled. Again, these are irreconcilable disparate teachings.

Even if the references were combinable, the combination does not teach or suggest Applicants' invention. *Baba* teaches that the product stream must first be distilled before gases are separated, and follows his distillation by a cooler (condenser) and gas/liquid separator. *Williams* teaches that the product stream is condensed to separate gas from liquid phase reactants, followed by chemical treatment or membrane separation.

Applicants do not perform either of these processes. Applicants feed the product stream at system pressure to an acetic acid-charged scrubber which creates a liquid phase containing even more acetic acid than the product stream, directly contrary to *Baba*, who teaches that vinyl acetate and acetic acid should be first separated to the highest degree possible. Applicants also do not employ a condenser, as taught by *Williams*. A condenser, which must be cooled, is much more energy intensive than a scrubber, and the exit streams from a condenser are totally different from that of a scrubber.

In the *Williams*' process, all the recycle ethylene must be purified to remove carbon dioxide in order to recycle it back to the reactor and still maintain the high reactor ethylene content. In Applicants' process, only a portion of the ethylene must be treated to remove CO₂, since only a portion is recycled.

Thus, with respect to vinyl acetate, Applicants' process avoids complicated and expensive separation methods while also eliminating the need for massive purging of the reactor to remove inerts. As a result, some 50 kg CO₂/ton of vinyl acetate are prevented from entering the biosphere. At the same time, the space time yield of vinyl acetate production is increased, and the ethylene selectivity is increased as well. The ethylene which is not recycled is reused in other processes, for example acetic acid production. The net results are lower process costs, greater yield and selectivity, and "waste" of only a very small proportion of ethylene feedstock.

Neither *Williams* nor *Baba* teach or suggest these non-obvious results. *Baba* requires a complicated and expensive separation procedure prior to ethylene separation and optional purification, and flares much of the recovered ethylene. Applicants separate ethylene without an expensive condensation unit, without a distillation column, and without a membrane separator.

It is clear that when references are combined, all the salient features of each reference must be contained in the proposed combination. See, e.g. *In re Wesslau*, 147 USPQ 391, 393 (CCPA 1965). This legal requirement was not changed by *KSR v. Teleflex*, nor is *KSR* applicable to the present situation. In *KSR*, a limited number of alternative constructions were suggested by the prior art in a relatively simple mechanical case involving a brake pedal assembly. None of the references in *KSR* taught or suggested that any of the other references' teachings should not be used, or would be incompatible. Here, however, *Baba* teaches that direct condensation or other treatment of the product gas stream from the vinyl acetate oxidation reactor should be avoided. As *Baba* indicates, the presence of acetic acid (an acid catalyst) and water in the vinyl acetate results in destruction of vinyl acetate by conversion to acetaldehyde. Thus, the entire thrust of *Baba* is to avoid this loss of vinyl acetate by separating vinyl acetate from acetic acid in a distillation, prior to doing anything else. The use of an immediate distillation column of

Baba is a salient feature of *Baba*, and must, under the law, be present in any combination of *Baba* with any other reference.

Applicants proceed directly against the teachings of *Baba*. Rather than remove acetic acid from the vinyl acetate product stream to prevent loss of vinyl acetate, as taught necessary by *Baba*, Applicants actually wash (scrub) the product stream with acetic acid, which adds additional acetic acid to the liquid phase, which also contains water.

Baba is cited for partial recycle of the ethylene in the product stream. However, *Williams* teaches total recycle of ethylene. These teachings again are incompatible. More importantly, the reasons for Applicants' partial recycle of ethylene and that of *Baba's* are not the same. Applicants direct a portion of the ethylene recovered from the product stream to other processes. Thus, it is still used, but is not recycled back to vinyl acetate production. As a result, inerts including CO₂ are constantly removed from the reaction cycle. *Baba* does not require reuse of ethylene, but when he does so, only optionally removes CO₂, since in contrast to *Williams*, *Baba* allows up to 60% inerts in his process.

This is not a case such as *KSR* where these are a limited number of alternatives which the prior art indicates are compatible, and thus alternatives which one skilled in the art would combine with only the expected result. Rather, Applicants' process, first, employs a very distinct process using but one of many, many alternatives. For example, ethylene could be separated by flash drums, condensers, distillation columns, falling film evaporators, gas liquid separators, etc., and these could be used at system pressure, or at lower pressure, at higher pressure. The ethylene could be further purified as taught by *Williams* in a membrane separator, by chemical treatment, by cryogenic distillation, by diffusion, or by other techniques. The cited prior art discloses but few of these. Other prior art dealing with purification and separation disclose numerous others. The ethylene could also be discharged and not recycled at all. The combination of these numerous available process steps produces permutations which represent a huge number of possible combinations. This is not a case where only limited possibilities exist, and where the art does not caution against using them. Rather, there are numerous possibilities, and the art cited cautions against their use: *Williams* by his complete recycle of ethylene in

contrast to partial recycle, and *Baba* in teaching that distillation is necessary as a first step to separate vinyl acetate from acetic acid. Unlike *KSR*, Applicants have proceeded against the wisdom of the art.

Second, Applicants have not achieved "the expected result". In view of *Baba*, it would be expected that vinyl acetate yield would be lowered by Applicants' process due to destruction loss of vinyl acetate. However, that is not the case. Not only are vinyl acetate yield and ethylene selectivity increased by Applicants' process, but the more ethylene is not recycled, the better these parameters become, as illustrated by Examples 1, 2, and 3. This result is totally unexpected.

For the reasons expressed above, withdrawal of the rejection of claims 6 - 11 is solicited.

The Office has cited *Broz* and *Lippert* for reuse of non-recycled ethylene in other processes. However, neither reference discloses use of any recycle ethylene in such processes, nor would it be obvious to do so. *Williams* teaches total recycle of ethylene, and thus there is no ethylene left for reuse. *Baba* teaches venting of ethylene not recycled, but not use in other processes. *Baba* issued in 1968, and despite the fact that *Baba* was disclosed some 40 years ago, no one has disclosed, taught, or suggested that the ethylene in the off gas stream (16) be used for anything but recycle to the same process, or flared or used as fuel. There is no teaching or suggestion in any of the references that the impure ethylene, saturated with acetic acid (from the scrubber), and containing vinyl acetate, water, acetaldehyde and CO₂ (Applicants' stream 5) could even be useful in another process. If it had been obvious to do so, the much more pure stream of *Baba* would have been used for this purpose long ago. However, there is no disclosure and no suggestion in the art to do so. The impetus for reuse of the non-recycled ethylene has been first disclosed by Applicants, not by the prior art, and rejections must be based on fact. Withdrawal of the rejection on this basis is solicited as well.²

² In the Office Action, the Office states on page 5 that "silence" by *Baba* opens the possibility of reuse of ethylene. However, it is well established that a rejection cannot be made on the basis of silence. See, e.g. *In re Evanega*, 4 USPQ 2d 1249, 1251 (Fed. Cir. 1987).

Claims 12 and 13 have been rejected over the same combination of references. The Office states that such streams could be used in the process of *Williams*, citing ¶[0026] of *Williams*. However, this paragraph refers to the inlet stream of the reactor, not the recycle gas stream. Moreover, *Williams* indicates that CO₂ must be removed from the recycle ethylene, through chemical treatment or membrane separation. *Williams* does not disclose any gas stream composition as taught by Applicants, and neither does *Baba*, whose gas stream has been through distillation, condensation, and separation, and is only optionally treated to remove CO₂. The unique concentrations of the gases which are further limitations of claims 12 and 13 result from the unique process of Applicants, wherein the product gases are scrubbed with acetic acid, and a portion of this scrubbed gas is directed to other processes. The composition is not a matter of choice, but is dictated by Applicants' process. This gas composition is neither taught nor suggested by these references. It is noted that the ethylene recycle streams disclosed by *Baba* in Table 2 do not involve any chemical process to remove CO₂. Withdrawal of the rejection of claims 12 and 13 are solicited for the same reasons as for claim 6 - 11, and for the additional reasons set forth above.


Claim 14 has been rejected over *Williams* in view of *Baba* under 35 U.S.C. § 103(a).

The Office is incorrect that the format of claim 14 is that of a product-by-process claim. Claim 14 is a process claim. The examination of product-by-process claims on the basis of only the product does not apply to process claims. Claim 14 is dependent from claim 12, which includes all process steps a) through f). This is a pure process claim, with one of the process streams being defined by composition. It is not a product-by-process claim where a composition is defined by a process. Every claim limitation must therefore be met by the combination of references, not merely the composition of the CO₂-removed recycle stream, which is also not disclosed or suggested. Withdrawal of the rejection of claim 14 is solicited for these reasons as well as those discussed relative to claims 6 - 11 and 12 - 13.

Applicants submit that the claims are now in condition for Allowance, and respectfully request a Notice to that effect. If the Examiner believes that further discussion will advance the prosecution of the Application, the Examiner is highly encouraged to telephone Applicants' attorney at the number given below.

Please charge any fees or credit any overpayments as a result of the filing of this paper to our Deposit Account No. 02-3978.

Respectfully submitted,
Willibald Dafinger et al.

By 
William G. Conger
Reg. No. 31,209
Attorney/Agent for Applicant

Date: August 22, 2008

BROOKS KUSHMAN P.C.
1000 Town Center, 22nd Floor
Southfield, MI 48075-1238
Phone: 248-358-4400
Fax: 248-358-3351